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CATALOGUE OF DATA ON THORIUM INTAKE, ORGAN BURDEN AND EXCRETION

by

SENES Consultants Limited

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A report prepared by SENES Consultants Limited,
Under Contract To The Atomic Energy Control Board

Abstract

The Atomic Energy Control Board is initiating the critical evaluation of current biokinetic and dosimetric models applicable to estimating exposure to the common chemical and physical forms of thorium. The identification and location of the relevant sets of data are the first steps of this project. This report describes the collection methods used and presents catalogues of the data on human and animal studies that have resulted from exposures under controlled experimental conditions, chronic occupational or environmental situations and acute accidental conditions. The data was identified through the use of computerized literature searches of the Cancerlit, Chemical Exposure, Embase, BIOSIS, NTIS, INIS, MEDLINE and Occupational Safety and Health (NIOSH) data bases, library research and telephone contact with currently active researchers in the field. A table is presented which categorizes researchers in the field according to affiliation and country.

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Résumé

La Commission de contrôle de l'énergie atomique a entrepris une évaluation critique des modèles biocinétiques et dosimétriques applicables aux travailleurs sous rayonnements exposés aux composés de thorium. Les premières étapes de ce projet ont été l'identification et la localisation des ensembles de résultats pertinents. Le rapport décrit les méthodes utilisées pour collecter les informations et contient le catalogue des résultats obtenus chez l'homme et l'animal à la suite d'expositions expérimentales contrôlées, d'expositions professionnelles chroniques, ou d'expositions aiguës accidentelles. Les ensembles de résultats ont été identifiés au cours de recherches bibliographiques dans les banques de données BIOSIS, MEDLINE et "Occupational Health and Safety (NIOSH)", dans les bibliothèques, et par contact téléphonique avec les chercheurs actifs dans ce domaine. Une liste de ces chercheurs par spécialité et nationalité est donnée dans un tableau séparé.

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1.0 INTRODUCTION

The Atomic Energy Control Board (AECB) is initiating the critical evaluation of current biokinetic and dosimetric models applicable to radiation workers exposed to the common chemical and physical forms of thorium that are encountered. This undertaking will consist of:

a) critically reviewing the existing sets of data on thorium intake (or exposure), organ burden and excretion; and

b) critically reviewing and testing current biokinetic and dosimetric models for thorium

The identification and location of the relevant sets of data are the first steps of this project and are described here.

The objective of this project is to provide the AECB with a catalogue of the existing sets of data on thorium intake (or exposure), organ burden and excretion. The scope of work required that the data sets be identified, located and listed with a succinct description of their content.

This objective was achieved through the use of computerized literature searches, library research and telephone contact with currently active researchers in the field.

In Chapter 2, the overall approach to data collection has been described. The methodology used to search computerized data bases and to identify other library references is explained. A number of currently active researchers in the field have been contacted and identified for future reference. The characteristics of the literature summaries are described.

In Chapter 3, one page descriptions of each of the identified references relating to human data are presented alphabetically by author.

In Chapter 4, one page descriptions of each of the identified references relating to animal data are presented alphabetically by author.

Finally, the reference list and bibliography for both human and animal data is given.

2.0 DATA COLLECTION METHODOLOGY

Sources of thorium bioassay data on man and animals were located through the use of a computerized literature search, study of the reference list in several major review articles and reports published by experts in the field and finally by contacting active researchers.

The computerized literature search was carried out on the eight data bases BIOSIS Reviews, Cancerlit, Chemical Exposure, Embase, NTIS, INIS, MEDLINE and Occupational Health and Safety (NIOSH). The data bases are described in Table 1 and include references from as early as 1964 and as current as 1988. Many different disciplines are represented such as life sciences, biomedical sciences and occupational health and safety. The references in the data bases are drawn from international periodical literature, books, technical reports and reports of research development and engineering projects sponsored by government agencies.

Numerous review articles, books and conference proceedings, listed in Table 2, were identified as major sources of information for this study. The reference lists of these documents identified many publications of original research and investigations related to either human or animal bioassay for thorium. Applicable publications were added to the references in the last section of this report.

Another fruitful means of identifying applicable data for this report was to contact by telephone numerous researchers active in the field. The names and affiliations of those contacted are given in Table 3. All of the researchers were most helpful in identifying sources of bioassay data and provided reports

describing their recent work. This was not indicated in the table. However, entries in Table 3 have been included where researchers indicated that the results of current or soon to completed work will be available. This information will be useful during the next stage of this project.

By the means described above, a list of reports was compiled that addressed uptake, retention and/or excretion of thorium by man or animals. No attempt to judge the accuracy, validity or suitability of any of the results was made. The assessment of the data falls within the scope of the next stage of the project. The list of references has been given in the last section of this report and includes the title of the report, the author(s) name, date of publication and journal proceedings or book reference.

When it was possible to obtain copies and study the text (or abstracts) of these reports succinct descriptions were prepared. The report summaries were divided into two groups - summaries of human data are included in Chapter 3 and summaries of animal data are included in Chapter 4.

The summaries of human data include: the author(s) name(s); the title of the report; the publication containing the report; the author(s) affiliation; the number and sex of the subject(s); the type of exposure - accidental, occupational or controlled experiment; the administration - inhalation, ingestion or dermal; the radioisotope and chemical form; the dosage or exposure; the duration of exposure; the follow-up period; and indication of in-vivo, post mortem tissue, urine, fecal or other analysis. In cases where the data were assembled from secondary sources (another article, book, or abstract), a note was added to the comments category indicating the secondary source(s). If no description of data analysis was reported in an article, it was considered not performed. Where information concerning other

categories such as duration of exposure was not found, it was indicated by N/A (not available).

The summaries of animal data are similar with the exception that the entry, post mortem tissue analysis, was changed to sacrifice and tissue analysis.

TABLE 1

DATA BASES SEARCHED

	NTIS	Medline	INIS	BIOSIS
Time Period Covered	1964 to 1988	1980 to Mar. 1988	1970 to Dec. 1987	1969 to Mar. 1988
Description	Produced by the National Technical Information Service of the U.S. Dept. of Commerce	Produced by the U.S. National Library of Medicine and covers biomedical literature materials	International Nuclear Information System - Copywright held by Int'l Atomic Energy Agency	Covers the major publications of Biosciences Information service; comprehensive world-wide coverage of research in the life sciences.
Source	The database consists of government-sponsored research, development of and engineering reports of 3 major U.S. federal government agencies: U.S. Dept. of Energy, Dept. of Defense, National Aeronautics and Space Administration plus many other agencies.	Medline indexes articles from approximately 3200 journals in over 70 countries		Periodical literature monographs, books, technical reports, meetings, etc.

Table 1 (Continued)

	Occupational Safety and Health (NIOSH)	Chemical Exposure	Cancerlit	Embase (Excerpta Medica)
Time Period Covered	1973 to Aug. 1987	1974 to 1987		1963 to Nov. 1987 1982 to 1988
	Produced by the U.S. Institute for Occupational Safety and Health	Compiled by the Chemical Effects Information Centre at Oak Ridge National Lab	Sponsored by the International Cancer Research Data Bank in co-operation with the U.S. National Library of Medicine.	A comprehensive world-wide index of literature on human medicine and related disciplines.
	Covers 150 current journals in health and safety and related fields, and all NIOSH Publications	Materials are drawn from international journals, conferences and reports.	Cancerlit indexes articles from approximately 34,000 journals. Proceedings of meetings, government reports, symposia reports and monographs are also included.	

TABLE 2

REVIEW ARTICLES, BOOKS AND CONFERENCE PROCEEDINGS

Delayed Effects of Bone-Seeking Radionuclides (Ed. C.W. Mays et al.), 1969, Univ. Utah, Salt Lake City.

The Toxicity of Thorotrast; Third International Meeting, 1973, Denmark: Danish Atomic Energy Commission.

Assessment of Radioactive Contamination in Man; International Symposium, 1984.

Conference on Occupational Health Experience with Uranium, 1975. (Ch. Wrenn, M.E.) Arlington, Virginia.

The Inhalation of Radioactive Substances, Part 3: Uranium and Thorium; A Literary Review. U.S. Gov. Res. Devel. Rep., 1970. Vol. 70 (10), 49 LF-TR-1.

The Radiology of Radium and Thorotrast; Symposium, 1984. F.R. Germany.

Radiation Hazards in Mining; Control, Measurement and Medical Aspects. (Ed. Gomez, M.) 1983, New York: American Institute of Mining.

Occupational Radiation Safety in Mining, Proceedings of the International Conference. (Ed. Stocker, H.), 1984. Toronto: Canadian Nuclear Association, Vol. 2.

Assessment of Radioactive Organ and Body Burdens; Proceedings of a Symposium, 1971, Sweden.

The Radiobiology of Radium and Thorotrast. Supplements to Strahlentherapie, 1986, Vol. 80.

International Radiation Protection Association Meeting; Third International Congress, 1974. Washington, D.C.

Workshop on Modelling for Inhalation of Radioactive Materials, 1984, Oxford.

European Late Effects Project Group (EULEP), Proceedings of Symposium, 1981, Rotterdam: Harrwood Academic.

Biological Effects of Low-Level Radiation Pertinent to Protection of Man and His Environment. 1975, Chicago: Vol. 2.

TABLE 3

CONTACTS AND AFFILIATIONS

Dr. John Ballou Battelle Pacific Northwest Laboratory P.O. Box 999 Richland, Washington 99352 Tel: (509) 376-0900	Recently retired
Dr. Darrell Fisher Battelle Pacific Northwest Laboratory P.O. Box 999 Richland, Washington 99352 Tel: (509) 375-6852	
Dr. Ronald Kathren United States Uranium Registry P.O. Box 100 Richland, Washington 99352	
Dr. John Stather National Radiation Protection Board Chilton, Didcot Oxfordshire, England Tel: Arbingdon (0235) 831600	
Dr. MacDonald E. Wrenn Radiobiology Division University of Utah Salt Lake City, Utah, 84112 Tel: (801) 581-6600	Dr. Wrenn replied that he is currently doing some work in Brazil involving thorium. He also sent a list of references, some of which have been included in this report.

TABLE 4

AUTHORS LISTED BY COUNTRY AND CENTRE OF RESEARCH

BRAZIL

Rio de Janeiro University - Barcinski

CANADA

Atomic Energy of Canada Limited - Johnson

Atomic Energy Control Board

Canadian Nuclear Association - Stocker

Guelph, University of - Robinson, Kupsh

Health and Welfare Canada, Radiation Protection Bureau - Abbatt

CZECHOSLOVAKIA

Institute Hygieny and Epidemiologie, Prague - Dvorak

DENMARK

Danish Atomic Energy Commission - Kaul, Buckton

FRANCE

European Late Effects Project Group (EULEP), Angiers - Priest

F.R. GERMANY

Dahlheimer, Erfle

Deutsche Gesellschaft fuer Biophysik E.V. and of the Deutsche Gesellschaft fuer Mediziniche Physik E.V., - Schraub

Freie University, Berlin - Foell

Karlsruhe University, Fakultaet fuer Bio. und Geowissenschaften - Peter-Witt, Volf

INDIA

Bhabha Atomic Research Centre, Bombay - Unnikrishman

ITALY

International Atomic Energy Agency, Vienna.
Joint Research Centre - Ispra Establishment, Radiochemistry and Nuclear Chemistry Division, Ispra - Vocaturo

Table 4 (Continued)

UNITED STATES OF AMERICA

Battelle Northwest Lab - Rundo, Bhattacharyya, Conibear, Hoegerman, Holtzman, Ilcewicz, Kurchta, Larsen, Lucas, Stebbings, Stehney

Inhalation Toxicology Research Institute, Alburquerque, New Mexico - Guillmette

M.I.T. Radioactivity Centre - Dudley

Monsanto Research Corporation, Miamisburg, Ohio - Gilbert

New York University - Cohen, Eisenbud, Ibrahim, Losasso

Oak Ridge National Laboratory - Berger, Faust, Gonzales, Meyer

Pacific Northwest Laboratory - Ballou, Palmer, Stuart

Pittsburgh University, Pennsylvania - Schubert

United States Atomic Energy Commission - Ackerman, Allen

United States Atomic Energy Commission, Oak Ridge, Tennessee - Schwartz

United States Department of Energy, Oak Ridge, Tennessee - Van Middlesworth

University of Rochester, Atomic Energy Project - Boecker, Downs, Hodge, Thomas

University of Utah - Wrenn, Bruenger, Atherton, Jee, Saccomanno, Ibrahim, Mays, Stover

Washington University, Seattle - Nelson

3.0 CATALOGUE OF HUMAN DATA

HUMANS

Author(s)	**Argonne National Laboratory**
Title	**Environmental Research Division, Annual Report: Centre for Human Radiobiology, Part 2.**
Publication	**Argonne National Laboratory Annual Report, 1985. ANL--84-103-PT.2.**
Authors' Affiliation	**Same as above**
Subject of Study	**Radium dial workers**
Type of Exposure	**Uncontrolled, occupational**
Administration	**N/A**
Radioisotope/ Chemical Form	**N/A**
Dosage/Exposure	**N/A**
Duration of Exposure	**N/A**
Follow-up Period	**N/A**
In Vivo Measurement	**Yes - exhalation**
Post Mortem & Tissue Analysis	**No**
Urine analysis	**No**
Fecal analysis	**No**
Other analyses	**N/A**
Comments	**This report contains abstracts of study reports involving 2400 human radium cases and also studies involving dogs and large mammals. The content of this summary was obtained from the abstract only.**

HUMANS

Author(s)	Cohen, N.
Title	In Vivo Measurements of Exposed Individuals
Publication	In Vivo Measurements of Bone-Seeking Radionuclides. Progress Report, 1980.
Authors' Affiliation	Institute of Environmental Medicine, New York University
Subject of Study	Workers, father and son, residents of the Marshall Islands.
Type of Exposure	Occupational, uncontrolled environmental
Administration	inhalation, ingestion
Radioisotope/ Chemical Form	^{234}Th, plus others
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	Yes - whole body counting
Post Mortem & Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	Yes - all cases were measured with NaI (CsI(Tl)) detectors above the thorax or surrounding the head.
Comments	Report describes various studies on individuals with bone-seeking nuclides. Content of this summary was obtained from the abstract only.

HUMANS

Author(s)	Colard, J.F., Culot, J.P., Di Ferrante, E.
Title	Observation of Some Cases of Intern. Contamination by 75Se, 175Hf and Natural Thorium
Publication	International Symposium of the Assessment of Radioactive Contamination in Man, 1984, Paris: pp. 19-23.
Authors' Affiliation	Centre d'Etude de l'Energie Nuclaire, Mol; Controle-Radioprotection, Mol (Belgium).
Subject of Study	2 patients treated with selenomethionine; 2 patients with lung contamination by $175HfO_2$; 3 patients with lung contamination by ThO_2
Type of Exposure	Controlled for selenomethionine, uncontrolled for 175 HFO_2 and ThO_2
Administration	Inhalation
Radioisotope/ Chemical Form	ThO_2
Dosage/Exposure	N/A
Duration of Exposure	Variable
Follow-up Period	Variable
In Vivo Measurement	Yes - exhalation
Post Mortem & Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Content of this summary was obtained from abstract only

HUMANS

Author(s)	Conibear, S.A.
Title	Long Term Health Effects of Thorium Compounds on Exposed Workers: The Complete Blood Count
Publication	Health Physics, 1983, Vol. 44, Supplement, No. 1, pp. 231-237
Authors' Affiliation	Center for Human Radiobiology, Radiological and Envir. Research Division, Argonne National Lab., Argonne, IL
Subject of Study	273 male workers at a plant that refined monazite sand
Type of Exposure	Uncontrolled, occupational
Administration	Inhalation, ingestion
Radioisotope/ Chemical Form	Natural thorium, monazite sand
Dosage/Exposure	N/A
Duration of Exposure	Variable between 1940 and 1973
Follow-up Period	From 1976 to 1980
In Vivo Measurement	Gamma counting for lung burden, exhaled thoron
Post Mortem & Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	

HUMANS

Author(s)	Farid, I. and Conibear, S.A.
Title	Hepatic Function in Previously Exposed Thorium Refinery Workers as Compared to Normal Controls from the Health and Nutrition Survey
Publication	Health Physics, 1983, Vol. 44, Supplement, No. 1, pp. 221-230
Authors' Affiliation	Center for Human Radiobiology, Argonne National Lab., Argonne, IL
Subject of Study	275 male workers at a plant that refined monazite sand
Type of Exposure	Uncontrolled, occupational
Administration	Inhalation, ingestion
Radioisotope/ Chemical Form	Natural thorium, monazite sand
Dosage/Exposure	N/A
Duration of Exposure	Variable 1940 to 1973
Follow-up Period	1976 to 1980
In Vivo Measurement	Whole body counting and exhaled thoron
Post Mortem & Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Whole body counting and exhaled thoron results not presented in this paper.

HUMANS

Author(s)	Fisenne, I.M., Perry, P.M., Decker, K.M. and Keller, H.W.
Title	The Daily Intake of $^{234,235,238}U$, $^{228,230,232}Th$ and $^{226,228}Ra$ by New York City Residents
Publication	Health Physics, 1987, Vol. 53, No. 4, pp. 357-363.
Authors' Affiliation	Envir. Measurement Lab., U.S. Dept. of Energy, 376 Hudson Street, New York, NY
Subject of Study	New York City residents
Type of Exposure	N/A
Administration	Ingestion, inhalation
Radioisotope/ Chemical Form	Th 228, 230, 232
Dosage/Exposure	N/A
Duration of Exposure	Lifetime
Follow-up Period	N/A
In Vivo Measurement	No
Post Mortem & Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Measurement of Th 228, 230, 232 in food, water and air.

HUMANS

Author(s)	Fisher, D.R., Jackson, P.O. Brodaczynski, G.G. and Scherpelz, R.I.
Title	Levels of ^{234}U, ^{238}U and ^{230}Th in Excreta of Uranium Mill Crushermen.
Publication	Health Physics, 1983, Vol. 45, No.3, pp. 617-629.
Authors' Affiliation	Radiological Sciences Department, Battelle Pacific Northwest Laboratory, P.O. Box 999, Richland, Washington 99352
Subject of Study	14 uranium mill crushermen, 4 retired crushermen and 3 control men, 19 to 63 years of age
Type of Exposure	Occupational
Administration	Inhalation
Radioisotope/ Chemical Form	Alpha-emitters - ^{234}U, ^{238}U, and ^{230}Th of the ^{238}U decay series in uranium ore dust.
Dosage/Exposure	N/A
Duration of Exposure	Working life; variable from 5 to 20 years
Follow-up Period	Days 1, 3 and 4 during the 4-day off period at the completion of a monthly shift schedule
In Vivo Measurement	No
Post Mortem & Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	Purpose of the work was to determine whether ^{230}Th was preferentially retained in the body over either ^{234}U or ^{238}U.

HUMANS

Author(s)	Fisher, D.R. and Jackson, P.O.
Title	Reply to Singh and Wrenn Regarding Levels of ^{234}U, ^{238}U and ^{230}Th in Excreta of Uranium Mill Crushermen
Publication	Health Physics, 1986, Vol. 50, No. 2, pp. 302-303
Authors' Affiliation	Pacific Northwest Lab., Richland, WA
Subject of Study	14 uranium mill crushermen, 4 retired crushermen and 3 control men
Type of Exposure	Occupational
Administration	Inhalation
Radioisotope/ Chemical Form	U234, U238, Th230 in uranium ore dust
Dosage/Exposure	N/A
Duration of Exposure	From 5 to 20 years
Follow-up Period	Days 1, 3 and 4 during the 4 day off period at the completion of a monthly shift schedule
In Vivo Measurement	No
Post Mortem & Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	Further comments on the study by Fisher et al. "Levels of ^{234}U, ^{238}U and ^{230}Th in Excreta of Uranium Mill Crushermen", Health Physics, 1983, Vol. 45, No. 3, pp. 617-629.

HUMANS

Author(s)	Goldin, A.S. Magno, P.J., Geiger, F. and Janower, M.L.
Title	Radionuclides in Autopsy Samples from Thorostrast Patients
Publication	Health Physics, 1972, Vol. 22, No. 5, pp. 471-481
Authors' Affiliation	Northeastern Radiological Health Laboratory, Winchester, Mass.
Subject of Study	1 female 71 yr old, 1 male 66 yr old, both administered thorostrast
Type of Exposure	Diagnostic
Administration	Single injection
Radioisotope/ Chemical Form	Th232 as colloidal thorium dioxide
Dosage/Exposure	30 to 49 mL of thorostrast
Duration of Exposure	N/A
Follow-up Period	24 hours to 30 days after death
In Vivo Measurement	Whole body count on one patient
Post Mortem & Tissue Analysis	Spleen, liver, lymph nodes, adrenals, pancreas, kidney, vertebrae, lung, blood
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Th232 was translocated to the bone, 65% of Ra228 was eliminated from the body

HUMANS

Author(s)	Golubenkov, A.M., Malenchenko, A.F.
Title	The Content of Uranium, Thorium and Certain Trace Elements in the Hair of Industrial and Agricultural Residents
Publication	GIG Sanit., 1984, No.7, pp. 33-35
Authors' Affiliation	An Belorusskoj SSR, Minsk. Inst. Yadernoj Ehnergetiki
Subject of Study	Residents of two industrial regions and 2 villages in Byelorussia
Type of Exposure	Uncontrolled, environmental
Administration	N/A
Radioisotope/ Chemical Form	Arsenic, mercury, antimony, lead, uranium and thorium
Dosage/Exposure	N/A
Duration of Exposure	Lifetime
Follow-up Period	One-time sample
In Vivo Measurement	Yes - hair
Post Mortem & Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	Hair, by solid body track detectors
Comments	Content of this summary was obtained from abstract only

HUMANS

Author(s)	Ibrahim, S.A.,Wrenn, M.E. Singh, N.P., Cohen, N. and Saccomano, G.
Title	Thorium Concentration in Human Tissues from Two U.S. Populations
Publication	Health Physics, 1983, Vol. 44, Supplement, No. 1, pp. 213-220
Authors' Affiliation	Dept. of Radiology and Radiation Biology, Colorado State Univ., Fort Collins; Radiobiology Lab., Dept. of Pharmacology, Univ. of Utah, Salt Lake City, UT; Dept. of Envir. Med., New York Univ., New York, NY; St. Mary's Hospital, Grand Junction, Co.
Subject of Study	22 sets of human tissues (autopsy) from Grand Junction, Co. 10 sets from Washington, D.C.
Type of Exposure	Uncontrolled, environmental
Administration	Inhalation, ingestion
Radioisotope/ Chemical Form	Th232, Th230, Th228
Dosage/Exposure	N/A
Duration of Exposure	Lifelong
Follow-up Period	N/A
In Vivo Measurement	No
Post Mortem & Tissue Analysis	Lung, pulmonary lymph nodes, livers, kidney, bone, gonads, spleen, thyroid
Urine analysis	No
Fecal analysis	No
Other analyses	
Comments	

HUMANS

Author(s)	Irie, H. and Mori, W.
Title	Long Term Effects of Thorium Dioxide (Thorotrast) Administration on Human Liver
Publication	Acta. Pathol. Jpn., 1984, Vol. 34 (2), pp. 221-228.
Authors' Affiliation	Faculty of Medicine, Tokyo University, Japan
Subject of Study	2 Thorotrast patients
Type of Exposure	Controlled, diagnostic
Administration	Injection
Radioisotope/ Chemical Form	$^{232}ThO_2$
Dosage/Exposure	N/A
Duration of Exposure	Single injection
Follow-up Period	Analysis 30 years after injection
In Vivo Measurement	No
Post Mortem & Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	Yes - liver biopsy specimens
Comments	Discusses two removal mechanisms in the liver.

HUMANS

Author(s)	Kaul, A. and Muth, H.
Title	Thorotrast Kinetics and Radiation Dose: Results from Studies in Thorotrast Patients and from Animal Experiments
Publication	Radiation and Environmental Biophysics, 1978, Vol. 15, pp. 241-259.
Authors' Affiliation	Freie Universitat Berlin, Universitat des Saarlandes, Federal Republic of Germany.
Subject of Study	Thorotrast patients
Type of Exposure	Controlled, diagnostic
Administration	Intravascular injection
Radioisotope/ Chemical Form	Th232 in colloidal thorium dioxide
Dosage/Exposure	Variations of dosage - one time exposure
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	N/A
Post Mortem & Tissue Analysis	Yes - liver, spleen, bone marrow, lungs, kidneys, skeleton.
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	
Comments	

HUMANS

Author(s)	Kemmer, W.
Title	A Field Study in 156 Thorotrast Cases: Results of Biophysical Measurements and Clinical Examinations
Publication	Environmental Research, 1979, Vol. 18, pp. 147-151
Authors' Affiliation	Institut fur Biophysik der Universitat der Saaarlandes, Boris Rajewsky Institut D-6650 Homburg (Saar), West Germany
Subject of Study	156 thorostrast patients (confined to their homes)
Type of Exposure	Controlled diagnostic
Administration	Intravascular injection
Radioisotope/ Chemical Form	Th232 in colloidal thorium dioxide
Dosage/Exposure	Variation of dosage - one time injection
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	Thoron exhaled in breath
Post Mortem & Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Blood tests carried out, liver disease identified

HUMANS

Author(s)	Linsalata, P., Eisenbud, M. and Franca, E.P.
Title	Ingestion Estimates of Th and the Light Rare Earth Elements Based on Measurements of Human Feces.
Publication	Health Physics, 1986, Vol. 50, No.1, pp. 163-167.
Authors' Affiliation	Institute of Environmental Medicine, New York Univ.
Subject of Study	16 individual feces samples from residents near a Th ore body in Brazil and 11 fecal samples from 10 residents of N.Y. state
Type of Exposure	Uncontrolled; in food and water
Administration	Ingestion
Radioisotope Chemical Form	Natural environmental Th232, Th228, Th230
Dosage/Exposure	N/A
Duration of Exposure	Lifetime
Follow-up Period	One sample
In Vivo Measurement	No
Post Mortem & Tissue Analysis	No
Urine analysis	No
Fecal analysis	Yes
Other analyses	No
Comments	Measurements were made of the concentration of ^{232}Th, La, Ce, Sm, ^{230}Th and ^{228}Th in the feces of people living close to a Th ore body, and of people living in a more typical rare-earth concentration situation.

HUMANS

Author(s)	Lucas, H.F., Edington, D.N. and Marhun, F.
Title	Natural Thorium in Human Bone
Publication	Health Physics, 1970, Vol. 19, No. 6, pp. 739-742
Authors' Affiliation	Radiological Physics Division, Argonne National Laboratory, Argonne, IL
Subject of Study	38 normal males and females, 3 to 91 years of age
Type of Exposure	Natural environmental
Administration	Ingestion, inhalation
Radioisotope/ Chemical Form	Th232
Dosage/Exposure	N/A
Duration of Exposure	Lifetime
Follow-up Period	N/A
In Vivo Measurement	No
Post Mortem & Tissue Analysis	Measurement of Th232 in rib bone
Urine analysis	No
Fecal analysis	No
Other analyses	Some rib bone samples were collected during surgery.
Comments	

HUMANS

Author(s)	Malatova, I. and Dvorak, V.
Title	Results of the Whole-Body Counting of Patients with Known Amount of Injected Thorotrast
Publication	Health Physics, 1970, Vol. 18, pp. 431-432
Authors' Affiliation	Institute of Radiation Hygiene, Prague 10, Srobarova 48 Czechoslovakia
Subject of Study	7 male thorotrast patients
Type of Exposure	Controlled diagnostic
Administration	Intravascular injection
Radioisotope/ Chemical Form	Th232 as colloidal thorium dioxide
Dosage/Exposure	One or two 20 mL injections
Duration of Exposure	One or two injections
Follow-up Period	At 17 to 21 year after injection
In Vivo Measurement	Whole body counting
Post Mortem & Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	

HUMANS

Author(s)	Maletskos, C.J., Keane, A.T., Telles, N.C. and Evans, R.D.
Title	Retention and Absorption of ^{224}Ra and ^{234}Th and Some Dosimetric Considerations of ^{224}Ra in Human Beings.
Publication	Delayed Effects of Bone-Seeking Radionuclides (Ed.Mays, C.W.) 1969
Authors' Affiliation	Cancer Research Institute, Harvard Univ., Boston; Mass.,
Subject of Study	Normal males and females, aged 63 to 83 yrs.
Type of Exposure	Controlled
Administration	Ingestion and injection
Radioisotope/ Chemical Form	Mock radium dial paint - $^{224}RaSO_4$, $^{234}Th(SO_4)_2$ $BaSO_4$, and ZnS phosphor ingestion, ^{234}Th citrate or ^{224}Ra chloride injection
Dosage/Exposure	N/A
Duration of Exposure	One ingestion/injection
Follow-up Period	Ingestion -110 days, injection - 21 days
In Vivo Measurement	Whole body counting
Post Mortem & Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	Blood and breath.
Comments	The study followed closely the original dial painter conditions, in order to simulate the actual dose those workers received. Other human and animal absorption and excretion study results are also presented.

HUMANS

Author(s)	Mamuro, T. and Mizohata, A.
Title	Determination of Thorium Series Nuclides in Thorotrast Patients.
Publication	Radioisotopes, 1978, Vol. 27, No.9, pp. 499-503.
Authors' Affiliation	Radiation Center of Osaka Prefecture, Sakai, Japan.
Subject of Study	Thorotrast patient
Type of Exposure	Controlled, diagnostic
Administration	Injection
Radioisotope/ Chemical Form	ThO_2 colloidal
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	One-time analysis
In Vivo Measurement	No
Post Mortem & Tissue Analysis	Yes - stomach, liver, spleen, kidney, brain
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Content of this summary was obtained from the abstract only.

HUMANS

Author(s)	Mausner, L.F.
Title	Inhalation Exposures at a Thorium Refinery
Publication	Health Physics, 1982, Vol. 42, No.2, pp. 231-236.
Authors' Affiliation	Centre for Human Radiobiology, Argonne National Laboratory, Argonne, IL.
Subject of Study	Two former employees of a thorium refinery
Type of Exposure	Uncontrolled, occupational
Administration	Inhalation
Radioisotope/ Chemical Form	^{232}thorium in dust and ^{220}Rn, ^{212}Pb, ^{212}Bi
Dosage/Exposure	Estimated
Duration of Exposure	3 years and 33 years working life at plant
Follow-up Period	After plant closure
In Vivo Measurement	No
Post Mortem & Tissue Analysis	Yes - lung, lymph nodes, liver, spleen, kidney
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	

HUMANS

Author(s)	Mayya, Y.S., Prasad, S.K., Nambiar, P.P.V.J., Kotrappa P., and Somasundaram, S.
Title	Measurement of ^{220}Rn in Exhaled Breath of Th Plant Workers.
Publication	Health Physics, 1986, Vol. 51, No.6, pp. 737-744.
Authors' Affiliation	Health Physics Division, Bhabha Atomic Research Centre, Trombay, Bombay, India
Subject of Study	176 Thorium refinery workers
Type of Exposure	Uncontrolled, occupational
Administration	Inhalation
Radioisotope/ Chemical Form	^{232}Th, ^{228}Ra, ^{228}Th, ^{224}Ra and decay products, thorium hydroxide, nitrate, oxide, plus others
Dosage/Exposure	Variable, depending on work setting and years of work
Duration of Exposure	Variable - from less than 12 years working to 24+ years working
Follow-up Period	
In Vivo Measurement	Yes - exhaled breath radioactivity measurements
Post Mortem & Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	

HUMANS

Author(s)	McNeill, K.G., Harrison, J.E., Mirza, K.F. Tai-Pow, J., Geale, D.C. and Barnett, H.J.M.
Title	Thorium Body Burdens in Humans Following Thorotrast Myelography and the Incidence of Myelopathy
Publication	British J. Radiol, 1968, 41, pp. 755-761
Authors' Affiliation	Dept. of Physics and Med., U. of T. and the Rad. Protection Lab. of the Dept. of Health of the Government of Ont., Canada
Subject of Study	9 patients administered thorotrast
Type of Exposure	controlled diagnostic
Administration	single injection
Radioisotope/ Chemical Form	Colloidal $^{232}ThO_2$
Dosage/Exposure	1 to 6 g of Th232
Duration of Exposure	Single injection
Follow-up Period	Measurements made 27 or 28 years after injection
In Vivo Measurement	Whole body counting of Ac228 and Th208 and thoron in breath measurements
Post Mortem & Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	

HUMANS

Author(s)	Molla, M.A.R.
Title	Radionuclides in the Autopsy Samples from Thorotrast Patients
Publication	Health Physics, 1975, Vol. 28, pp. 295-297
Authors' Affiliation	Health Physics Division, Atomic Energy Centre, Dacca, Bangladesh
Subject of Study	Thorotrast patients
Type of Exposure	Controlled diagnostic
Administration	Single injection
Radioisotope/ Chemical Form	Colloidal $^{232}ThO_2$
Dosage/Exposure	N/A
Duration of Exposure	single injection
Follow-up Period	Measurements 20-25 years after injection
In Vivo Measurement	No
Post Mortem & Tissue Analysis	Soft tissue, bone marrow, marrow-free bone,
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	
Comments	

HUMANS

Author(s)	Molla, M.A.R., Harrison, J.E. and McNeill, K.G.
Title	Doses to the Canda Equina due to Thorotrast Myelography
Publication	Health Physics, 1976, Vol. 31, pp. 109-114.
Authors' Affiliation	Dept. of Physics and of Medicine, Univ. of Toronto, Ontario, Canada
Subject of Study	3 thorotrast patients
Type of Exposure	controlled diagnostic
Administration	single injection
Radioisotope/ Chemical Form	colloidal $^{232}ThO_2$
Dosage/Exposure	approx. 1 to 6 g Th^{232}
Duration of Exposure	death 22, 24 and 28 years post-injection
Follow-up Period	No
In Vivo Measurement	No
Post Mortem & Tissue Analysis	measurements of canda equina, liver, spleen
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	

HUMANS

Author(s)	**Morsy, S.M., Jahns, E. and Aloush, A.A.**
Title	**In Vivo Gamma Spectrometric Investigation of Thorium Body Burdens in the Egyptian Monazite Area**
Publication	**Health Physics, 1970, Vol. 18, pp. 263-266.**
Authors' Affiliation	**Rad. Protection Dept., Atomic Energy Establishment, Cairo, Egypt, U.A.R.**
Subject of Study	**14 workers at black sand refinery and 10 local inhabitants**
Type of Exposure	**uncontrolled occupational and environmental**
Administration	**inhalation and ingestion**
Radioisotope/ Chemical Form	**N/A**
Dosage/Exposure	**N/A**
Duration of Exposure	**lifetime**
Follow-up Period	
In Vivo Measurement	**whole-body gamma counting**
Post Mortem & Tissue Analysis	**No**
Urine analysis	**No**
Fecal analysis	**No**
Other analyses	**No**
Comments	**No measureable body burdens**

HUMANS

Author(s)	Newton, D., Rundo, J., and Eakins, J.D.
Title	Long-Term Retention of ^{228}Th Following Accidental Intake.
Publication	Health Physics, 1981, Vol. 40, No.3, pp. 291-298.
Authors' Affiliation	Atomic Energy Research Establishment, Harwell, England
Subject of Study	1 man
Type of Exposure	Uncontrolled
Administration	Accidental inhalation
Radioisotope/ Chemical Form	^{228}Th in oxide form
Dosage/Exposure	Unknown
Duration of Exposure	Unknown
Follow-up Period	7 years
In Vivo Measurement	whole-body counting
Post Mortem & Tissue Analysis	No
Urine analysis	Yes
Fecal analysis	Yes
Other analyses	No
Comments	

HUMANS

Author(s)	Nishidai, T., Torizuka, K., Morita, R., Komuro H. and Fukunaga, m.
Title	Determination of Thorotrast Amount Deposited in Patients.
Publication	Radioisotopes, 1978, Vol. 27, No.3, pp. 139-142.
Authors' Affiliation	Kyoto University, Faculty of Medicine, Japan
Subject of Study	Thorotrast Patients
Type of Exposure	Controlled, diagnostic
Administration	Injection
Radioisotope/ Chemical Form	$^{232}ThO_2$, colloidal
Dosage/Exposure	Not available from abstract
Duration of Exposure	N/A
Follow-up Period	One time analysis
In Vivo Measurement	N/A
Post Mortem & Tissue Analysis	N/A
Urine analysis	No
Fecal analysis	No
Other analyses	spleen, liver
Comments	Content of this summary was obtained from the abstract only.

HUMANS

Author(s)	Ohta, M. and Tomura, K.
Title	Contents of Several Trace Elements in Human Stones
Publication	Nippon Kagaku Kaishi, 1977, Vol. 11, pp. 1639-1647.
Authors' Affiliation	Tokyo Metropolitan University, Faculty of Science, Japan.
Subject of Study	human tissues
Type of Exposure	uncontrolled environmental
Administration	inhalation, ingestion
Radioisotope	
Chemical Form	N/A
Dosage/Exposure	N/A
Duration of Exposure	lifetime
Follow-up Period	N/A
In Vivo Measurement	No
Post Mortem & Tissue Analysis	22 human gallstones, 11 urinary calculi and one phlebolite
Urine analysis	No
Fecal analysis	No
Other analyses	
Comments	Content of this summary was obtained from the abstract only.

HUMANS

Author(s)	Rundo, J., Polednak, A.P., Brues, A.M., Lucas, H.F., Jr., Patten, B.C., Rowland, R.E. and Stehney, A.F.
Title	A Study of Radioactivity and Health Status of Former Thorium
Publication	Environmental Research, 1979, Vol. 18, pp. 94-100
Authors' Affiliation	Center for Human Radiobiology, Argonne, National Lab., Argonne, Illinois
Subject of Study	46 former male workers at a thorium refinery
Type of Exposure	uncontrolled, occupational
Administration	inhalation, ingestion
Radioisotope/ Chemical Form	Th^{232}
Dosage/Exposure	N/A
Duration of Exposure	1930-1973
Follow-up Period	one set of measurements
In Vivo Measurement	whole-body counting and thoron in breath
Post Mortem & Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	

HUMANS

Author(s)	Rundo, J., Brewster, D.R., Essling, M.A., and Sha, J.Y.
Title	Radioactivity in Former Workers at a Thorium Refinery
Publication	Actinides in Man and Animals, 1981, (Ed. Wrenn, M.E.) RD Press: pp. 261-267.
Authors' Affiliation	N/A
Subject of Study	200 former male workers at a thorium refinery
Type of Exposure	Uncontrolled, occupational
Administration	Inhalation, injestion
Radioisotope/ Chemical Form	N/A
Dosage/Exposure	N/A
Duration of Exposure	Variable; working life
Follow-up Period	After plant closure
In Vivo Measurement	Yes - exhalation measurements
Post Mortem & Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Content of this summary was obtained from the abstract only

HUMANS

Author(s)	Rundo, J., Huff, D.R. and Kuchta, D.R.
Title	Measurements of Radioactivity in Former Thorium Workers
Publication	Argonne National Lab Report, 1977, No.ANL-77-65 (Pt.2), pp. 91-92.
Authors' Affiliation	Argonne National Laboratory, Illinois
Subject of Study	former male thorium refinery workers.
Type of Exposure	Uncontrolled, occupational
Administration	Inhalation
Radioisotope/ Chemical Form	Thorium dust and thoron
Dosage/Exposure	N/A
Duration of Exposure	One year or longer
Follow-up Period	One time analysis
In Vivo Measurement	whole-body counting and thoron in breath
Post Mortem & Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Content of this summary was obtained from the abstract only.

HUMANS

Author(s)	Singh, N.P., Ibrahim, S.A. and Wrenn, M.E.
Title	Comparative Distribution of Plutonium and Natural Thorium in the Same Samples of Human Lung and Lymph Nodes and its Relevance on Pulmonary Clearance Classification for Lung Models.
Publication	Presented at Twenty-four annual Meeting of Health Physics Society, 1979
Authors' Affiliation	Institute of Environ. Medicine, New York, University Medical Centre
Subject of Study	6 sets of human tissues, no known occupational exposures
Type of Exposure	uncontrolled environmental
Administration	inhalation, ingestion
Radioisotope/ Chemical Form	Th228, 230 and 232
Dosage/Exposure	N/A
Duration of Exposure	lifetime
Follow-up Period	N/A
In Vivo Measurement	No
Post Mortem & Tissue Analysis	lung, lymph nodes, liver, bone, kidney and spleen
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	

HUMANS

Author(s)	Singh, N.P., Bennett, D.B., Wrenn, M.E. and Saccomanno, G.
Title	Concentration of Alpha-Emitting Isotopes of U and Th in Uranium Miners' and Millers' Tissues
Publication	Health Physics 1987, Vol. 53, No.3, pp. 261-265.
Authors' Affiliation	Univ. Utah, Salt Lake City
Subject of Study	3 deceased uranium miners and 2 deceased uranium millers
Type of Exposure	Uncontrolled, occupational
Administration	Inhalation, ingestion
Radioisotope Chemical Form	^{234}U, ^{235}U, ^{238}U and ^{228}Th, ^{230}Th, ^{232}Th
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	No
Post Mortem & Tissue Analysis	Yes - lung, liver, kidney, spleen, gonad, heart and vertebrae, ribs and sternum
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	

HUMANS

Author(s)	Singh, N.P., Bennett, D., Saccomanno, G. and Wrenn, M.E.
Title	Concentrations of ^{210}Pb in Uranium Miners' Lungs and its States of Equilibria with ^{238}U, ^{234}U and ^{230}Th.
Publication	Occupational Radiation Safety in Mining, Vol. 2., (Ed. H. Stocker). Canadian Nuclear Association, Toronto: 1984, pp. 503-506
Authors' Affiliation	Radiobiology Division, Dept. of Pharmacology, Univ. of Utah School of Medicine, Salt Lake City, Utah
Subject of Study	Lungs of deceased uranium miners
Type of Exposure	Uncontrolled
Administration	Inhalation
Radioisotope Chemical Form	Th^{230}
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	No
Post Mortem & Tissue Analysis	Yes - lungs
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	

HUMANS

Author(s)	Singh, N.P., Wrenn., M.E. and Ibrahim, S.A.
Title	Plutonium Concentration in Human Tissues: Comparison to Thorium
Publication	Health Physics, 1983,Vol. 44., Supplement, No. 1, pp. 469-476
Authors' Affiliation	Radiobiology Division, Dept. of Pharmacology, Univ. of Utah, College of Medicine, Salt Lake City, UT; Dept. of Radiobiology, Colorado State Univ., Fort Collins, CO.
Subject of Study	10 sets of human tissues from Washington, D.C. and 12 sets from Grand Junction, Colorado
Type of Exposure	environmental, uncontrolled
Administration	inhalation, injestion
Radioisotope/ Chemical Form	environmental Th^{232}
Dosage/Exposure	N/A
Duration of Exposure	lifetime
Follow-up Period	after death
In Vivo Measurement	No
Post Mortem & Tissue Analysis	lung, tracheobronchial lymph node, liver, kidney, bone, spleen, gonads, thyroid
Urine analysis	NO
Fecal analysis	No
Other analyses	No
Comments	

HUMANS

Author(s)	Singh, N.P., Bennett, D.B., Wrenn, M.E. and Saccomanno, G.
Title	Concentrations of ^{210}Pb and its States of Equilibrium with ^{238}U, ^{234}U and ^{230}Th in Uranium Miners' Lungs.
Publication	Health Physics, 1986, Vol. 51, No.4, pp. 501-507
Authors' Affiliation	University of Utah, Salt Lake City
Subject of Study	Uranium miners
Type of Exposure	Uncontrolled, occupational
Administration	Inhalation
Radioisotope Chemical Form	Th^{230}
Dosage/Exposure	Variable - from 6.8×10^{-3} to 7.2×10^{-1} mg/y for ^{238}U, ^{234}U, and ^{230}Th combined.
Duration of Exposure	Variable, working life
Follow-up Period	measurements after death
In Vivo Measurement	No
Post Mortem & Tissue Analysis	Yes - lungs
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Content of this summary was obtained from the abstract only.

HUMANS

Author(s)	Singh, N.P., Wrenn, M.E., Archer, V.E. and Saccomanno, G.
Title	^{238}U, ^{234}U and ^{230}Th in Uranium Miners' Lungs
Publication	Radiation Hazards in Mining. Ed. M. Gomez, Am. Inst. of Mining, 1981.
Authors' Affiliation	Univ. Utah, Salt Lake City, and St. Mary's Hospital, Colorado
Subject of Study	Lungs of 14 deceased uranium miners
Type of Exposure	Uncontrolled, occupational
Administration	Inhalation, ingestion
Radioisotope/ Chemical Form	^{238}U, ^{234}U and ^{230}Th
Dosage/Exposure	N/A
Duration of Exposure	Working life (not given)
Follow-up Period	N/A
In Vivo Measurement	No
Post Mortem & Tissue Analysis	Yes - lungs
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	

HUMANS

Author(s)	Soman, S.D.
Title	Background Radioactivity in the Monazite Areas of Kerala, India.
Publication	Kernforschung sanlage Juelich, GmdH, F.R. Germany Report No. Juel-Spez-161, 1982
Authors' Affiliation	Same as above
Subject of Study	10,000 persons living in the areas of the southwest coast of India.
Type of Exposure	uncontrolled, environmental
Administration	inhalation, ingestion
Radioisotope/ Chemical Form	Th^{232}, Th^{228}
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	Yes - exhalation
Post Mortem & Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	The content of this summary was taken from the abstract only.

HUMANS

Author(s)	Stebbings, J.H.
Title	Personal Factors Affecting Thoron Exhalation from Occupationally Acquired Thorium Body Burdens
Publication	Argonne National Lab. Report No. ANL-84-103-Pt2, 1984, pp. 60-73.
Authors' Affiliation	Argonne National Laboratory, Illinois
Subject of Study	Thorium workers
Type of Exposure	Uncontrolled, occupational
Administration	Inhalation
Radioisotope Chemical Form	Thorium dust, thoron
Dosage/Exposure	N/A
Duration of Exposure	Variable; working life
Follow-up Period	N/A
In Vivo Measurement	Yes - exhalation measurements of thoron
Post Mortem & Tissue Analysis	No
Urine analysis	Urine Analysis
Fecal analysis	No
Other analyses	No
Comments	Content of this summary was obtained from the abstract only.

HUMANS

Author(s)	**Steinstrasser, A. and Kemmer, W.**
Title	**Biophysical Investigations of the Dose-Effect Relationship in Chromosome Aberrations of Human Lymphocytes Caused by Thorotrast Deposits**
Publication	**Radiat. Environ. Biophys., 1981, Vol. 19, pp. 17-28.**
Authors' Affiliation	**Institut fur Biophysik, Boris Rajewsky-Institut, Homburg (Saar), FDR**
Subject of Study	**lymph nodes of thorotrast patients**
Type of Exposure	**controlled, diagnostic**
Administration	**injection**
Radioisotope/ Chemical Form	**colloidal ThO_2**
Dosage/Exposure	**N/A**
Duration of Exposure	**single injection to death**
Follow-up Period	**N/A**
In Vivo Measurement	**No**
Post Mortem & Tissue Analysis	**lymph nodes**
Urine analysis	**No**
Fecal analysis	**No**
Other analyses	**No**
Comments	

HUMANS

Author(s)	Vocaturo, G., Colombo, F., Zanoni, M., Rodi, F., Sabbioni, E. and Pietra, R.
Title	Human Exposure to Heavy Metals - Rare Earth Pneumoconiosis in Occupational Workers
Publication	Chest, 1983, Vol. 5, pp. 780-783.
Authors' Affiliation	Presidio Ospedaliero, Division of Pneumology, Cuasso al Monte, Varese, Italy. Commission of the European Communities, Radiochemistry and Nuclear Chemistry Division, Joint Research Centre - Ispra Establishment, Ispra, Italy
Subject of Study	58 yr. old male worker in photoengraving lab
Type of Exposure	uncontrolled, occupational
Administration	inhalation, ingestion
Radioisotope/ Chemical Form	Th^{232}
Dosage/Exposure	N/A
Duration of Exposure	worked 46 years in photoengraving lab
Follow-up Period	N/A
In Vivo Measurement	No
Post Mortem & Tissue Analysis	No
Urine analysis	No
Fecal analysis	No
Other analyses	lung and lymph nodes biopsy specimens analyzed
Comments	

HUMANS

Author(s)	Wegener, K. and Wesch, H.
Title	Pathological Changes of Lymph Nodes in Thorotrast Patients: Pathoanatomical, Autoradiographical, and Quantitative Investigations
Publication	Environ. Res., 1979. Vol. 18, No.3, pp. 245-255.
Authors' Affiliation	Municipal Hospital of Ludwigshafen, Germany
Subject of Study	38 deceased thorotrast patients
Type of Exposure	Controlled, diagnostic
Administration	Injection
Radioisotope Chemical Form	$^{232}ThO_2$ colloidal
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	One-time, analysis
In Vivo Measurement	No
Post Mortem & Tissue Analysis	Yes - lymph nodes, spleen, liver
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Content of this summary was taken from the abstract only.

4.0 CATALOGUE OF ANIMAL DATA

ANIMALS

Author(s)	**Ballou, J.E.**
Title	**Effect of Ventilation Variables on Breath Thoron Output (Dogs)**
Publication	**Symposium on Noble Gases, 1973, pp. 520-526.**
Authors' Affiliation	**Battelle Pacific Northwest Lab., Richland, Washington.**
Subject of Study	Dogs
Type of Exposure	Controlled
Administration	Intramuscular injection or inhalation
Radioisotope Chemical Form	Th^{228} enriched as the oxide
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	N/A
In Vivo Measurement	radon in breath
Post Mortem & Tissue Analysis	artificial exhalation of excised lungs
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Content of this summary was obtained from the abstract only.

ANIMALS

Author(s)	Ballou, J.E. and Hursh, J.B.
Title	The Measurement of Thoron in the Breath of Dogs Administered Inhaled or Injected ThO_2.
Publication	Health Physics, 1972, Vol. 22, pp. 155-159.
Authors' Affiliation	Dept. of Radiation Biology and Biophysics, University of Rochester, Rochester, New York.
Subject of Study	10 female beagle dogs
Type of Exposure	Controlled
Administration	Inhalation, intravenous intramuscular and intra-arterial injection.
Radioisotope Chemical Form	ThO_2 enriched in Th228
Dosage/Exposure	188 mg/m^3
Duration of Exposure	for 5 to 30 minutes
Follow-up Period	up to 150 days after inahlation exposure
In Vivo Measurement	radon in breath, lung counting
Post Mortem & Tissue Analysis	lungs
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	

ANIMALS

Author(s)	Ballou, J.E., Buschbom, R.L., Case, A.C., Dagle, G.E., Gies, R.A. and Ryan, J.L.
Title	Toxicity of the Thorium Cycle Nuclides
Publication	Pacific Northwest Lab. Annual Report, 1986, PNL-6100 PT1, pp. 41-43.
Authors' Affiliation	Pacific Northwest Laboratory, Richland, Washington.
Subject of Study	Male Wistar Rats
Type of Exposure	Controlled
Administration	Inhalation, intratracheal instillation
Radioisotope Chemical Form	$^{233}UO_2(NO_3)_2$, $^{232}UO_2(NO_3)_2$, ^{238}Pu nitrate aerosols, ^{253}Es
Dosage/Exposure	0.6 to 53 nCi initial lung burden
Duration of Exposure	N/A
Follow-up Period	Life span
In Vivo Measurement	Yes - lung burden
Post Mortem & Tissue Analysis	Yes - lungs, skeleton, kidney, liver, blood, muscle
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	

ANIMALS

Author(s)	Ballou, J.E., Gies, R.A. Wagman, N.A. and Wiley, W.R.
Title	Disposition of ^{232}U Decay Products following Inhalation of $^{232}UO_2(NO_3)O_2$ Aerosols.
Publication	Pacific Northwest Lab Annual Report, 1978, No. PNL-2500(Pt.1), pp. 3.83-3.84.
Authors' Affiliation	Pacific Northwest Laboratory, Richland, Washington.
Subject of Study	Rats
Type of Exposure	Controlled
Administration	Inhalation
Radioisotope/ Chemical Form	^{232}U, ^{228}Th, ^{224}Ra, ^{212}Pb
Dosage/Exposure	N/A
Duration of Exposure	N/A
Follow-up Period	200 days post-exposure
In Vivo Measurement	No
Sacrifice and Tissue Analysis	Yes - skeleton, lungs
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Content of this summary was obtained from the abstract only.

ANIMALS

Author(s)	Behari, J.R.,Gaur, J.S. and Tandon, S.K.
Title	Effect of Monazite Material in Rats
Publication	International Symposium on Industrial Toxicology, (Ed. Zaidi, S.H.), 1975, Lucknow, India, pp. 745-756.
Authors' Affiliation	Industrial Toxicology Research Centre, Lucknow, India.
Subject of Study	Albino Rats
Type of Exposure	Controlled
Administration	Inhalation
Radioisotope/ Chemical Form	Monazite dust - thorium and rare earth elements
Dosage/Exposure	N/A
Duration of Exposure	Various
Follow-up Period	Various intervals
In Vivo Measurement	No
Sacrifice and Tissue Analysis	lungs, liver and kidneys.
Urine analysis	No
Fecal analysis	No
Other analyses	No
Comments	Content of this summary was obtained from the abstract only.